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Hybrid power system of public lighting in smaller villages

Abstract. *This article deals with the possibility of public lighting power from renewable resources, it means of a hybrid system consisting of solar panels and wind power. The factual data for dimensioning the system was obtainedby extensive exploration of the state and consumption of public lighting in the villages of the Czech Republic. The article contains an economic reasoning and analysis of investment costs compared to cable distribution.*

Streszczenie. *Artykuł ten traktuje o możliwościach zasilania oświetlenia publicznego z odnawialnych źródeł energii, czyli systemu hybrydowego skladającego się z paneli słonecznych i elektrowni wiatrowej. Szczegółowe dane użyte do wszelkich wyliczeń uzyskano na podstawie szerokich badań dotyczączch stanu i zużycia energii przez oświetlenie publiczne w gmianch Republiki Czeskiej. Artykuł zawiera w sobe także uwagę ekonomiczną i analizę wydatków inwestycyjnych w porównaniu z siecią kablową.* ***(Hybrydowy system zasilania oświetlenia publicznego w mniejszych gminach).***

Keywords: public lighting, solar power station, wind power station, hybrid power source, energy balance.
Słowa kluczowe: oświetlenie publiczne, elektrownia słoneczna, elektyrownia wiatrowa, system hybrydowy, bilans energetyczny.

Introduction

During the realization of the SGS Project SP/201073 we have solved this year on the VSB-TU Ostrava, we implement a hybrid system using renewable energy sources (solar and wind power). These resources are applied to households with a defined power consumption. System consists of wind energy power 12kW and solar panels with capacity about 2kWp. Batteries are charging by the photovoltaic panels through the regulator.

Output of wind power is through the converter rectified into batteries, from which is continuously supplied simulated household during the time, according to its consumption. Based on this concept, we will try to apply the power of public lighting (hereafter PL) in small villages. The purpous is to modify the system so that can supply electricity public lighting in small villages or remote areas without power.

Statistical data on consumption

The data about electrical energy consumed by public lighting were obtained by extensive exploration, in which were subpoenaed cities and towns of the Czech Republic with a query about consumption in their city. The date we received was statistically processed and evaluated and results for small and medium-sized villages are listed in Table 1. Details of which we will determine are the installed power of one light point (hereafter SM) and the average number of lighting points per hundred inhabitants.

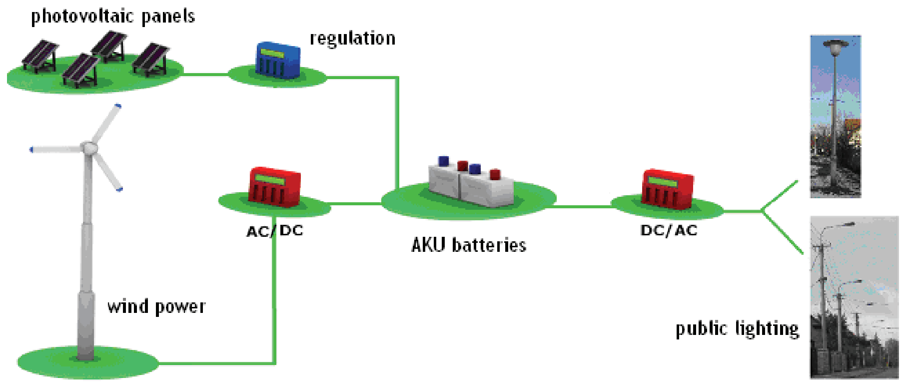

Fig.1. The concept of the proposed hybrid power system for public lighting

Table 1. Statistical data on electricity consumption of public lighting for small and medium-sized villages

size of the villages	power consumption to light point	power consumption per capita	installed power of light point	installed power per capita	number of lighting points per 100 inhabitant
	kWh/SM	*kWh/per capita*	*W/SM*	*W/per capita*	*SM/100 inhabitants*
< 500	329	57	78	14	17
500 - 1000	320	49	76	12	14
1000 - 5000	377	56	90	13	13

Table 3. Parameters and the price of a hybrid system

The various components of the system	Parameters	Valuation	Number of Units	Total
AKU -gel batteries	12V/230Ah	11 000 CZK	88	1 232 000 CZK
Photovoltaic panels	polycrystalline, 210Wp	13 000 CZK	29	377 000 CZK
Wind power	30kW	1 800 000 CZK	1	1 800 000 CZK
Inverters	do 25kW	300 000 CZK	1	300 000 CZK
Rectifier	do 25kW	70 000 CZK	1	70 000 CZK
Regulator	na 6kW	50 000 CZK	3	150 000 CZK
Rough estimate of the price of CZK 3,929 million				

Of the values listed in Table 1. is expressed the average number of lighting points and the average installed power for public lighting. In Table 2. is then calculated the average installed power of village public lighting. For the smallest intended village is power 6,63 kW, and this value will be dimensioned to hybrid system.

Table 2. Calculated data for public lighting

size of the villages	number of lighting points per 100 inhabitant	average number of light point	average installed power PL of village
-	*SM/100 inhabitants*	*ks*	*kW*
< 500	17	85	6,63
500 - 1000	14	140	10,64
1000 - 5000	13	650	58,5

Proposal of a hybrid system to power public lighting the village

For using this system year round it must be designed to operate in winter months when the public lighting consumes electricity 16 hours a day. With regard to the possible realization and investment costs are for the calculation considered villages in which there lives 500 inhabitants or less. For this category of villages, the average installed power on light point is 78W, as we count 85 light points. So we obtaine the installed power of public village lighting 6,63 kW. Power take-off from the rechargeable battery is designed for two nights during the winter without any charge from one or other renewable sources. The consumption for these two nights is 212kWh. During the summer demands for electricity are lower indeed, we consider the operation time only eight hours and a half consumption.

This system is used for illustrating the price costs of this kind of prototype and has function to explore whether is preferable to use a cable connection from the remote grid or need to build such a local island hybrid system. In both cases we expect that public lighting is newly built or will complete its reconstruction. The price of public lighting is not considered. Further there is the calculation and mutual comparation with a variant of remote connection and consumption of electrical energy to power 20 years, a life time of our hybrid system.

For making an idea there are compared different lengths of power connections with price of a hybrid system. The following table shows that the hybrid system is repayable under the conditions where the length of the power supply cable connections exceed 4 kms. The calculation consideres a standard rates of electricity for public lighting for the year 2010, which are fixed during all 20 years.

Table 4. Parameters and prices of electrical supply

Parameters	Price
Price of cable CYKY 3x2,5	20 CZK/m
Excavation work	340 CZK/m
Electricity consumption for 20 years (for tariff C62d PL)	691400 CZK

Table 5. Prices of electrical connections for various distances

Route length	Price including payment of consumption for 20 years
500m	861 400 CZK
1000m	1 031 400 CZK
5000m	5 157 000 CZK
10000m	10 314 000 CZK

Conclusion

This article shows theoretical possibility of solution of a separate power supply system for public lighting. Compares two different ways to power the locality and supply it by electrical energy. It demonstrate rough estimate of the cost for construction of electrical supply and costs of building the island hybrid system. The result shows that if the connection length exceeds 4 kms, the investment costs of these projects are equal. But if we take the life of the hybrid system maximum 20 years and the life of cable connection maximum 40 years then we have to submit that building connection with a length of 4 kms is much better from the economic point of view. For connections with a distance longer than 8 kms is preferable to install a hybrid system of the island power system. This application can be used especially for inaccessible areas with such a terrain, which would be considerably more expensive excavation works with regard to soil type and very remote areas, it means remote parkings and highway rest areas, a mountain cottages, villages or farms.

Acknowledgement

This article was created under project SP/201073, "Využití hybridních obnovitelných zdrojů elektrické energie"

REFERENCES

[1] Mišák, S., Prokop, L.: Analýza technických a ekonomických parametrů hybridních systémů. In 11th International Scientific Conference Electric Power Engineering 2010; (EPE 2010), 2010.

[2] Novák T., Mišák S., Sokanský, K.: Využití obnovitelných zdrojů energie k napájení svítidel veřejného osvětlení. In 11th International Scientific Conference Electric Power Engineering 2010; (EPE 2010), 2010.

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